GRASSROOTS JOURNALS

Grassroots Journal of Natural Resources, Vol.8 No.3 (December 2025)
ISSN: 2581-6853 | CODEN: GJNRA9 | Published by The Grassroots Institute
Website: https://grassrootsjournals.org/gjnr | Main Indexing: WoS, CABELL, EBSCO

ISSN 2581-6853 | 8(3) December 2025

00619 | Analytical Article

Legal Status of War-Damaged Forests in Ukraine: Challenges and Solutions

Nataliia Malysheva*[1], Dmytro Kovtun[2]
[1]Department of Agricultural, Land, Environmental, and Space Law at the Volodymyr Koretsky Institute of State and Law of the National Academy of Sciences of Ukraine, Kyiv, Ukraine.
Email: nataliia_malysheva@ukr.net | ORCID: https://orcid.org/0000-0001-6630-227X
[2]Department of Agricultural, Land, Environmental, and Space Law at the Volodymyr Koretsky Institute of State and Law of the National Academy of Sciences of Ukraine, Kyiv, Ukraine.
Email: ot99@ukr.net | ORCID: https://orcid.org/0009-0007-5684-0761
**Corresponding author*

How to cite this paper: Malysheva, N. and Kovtun, D. (2025). Legal Status of War-Damaged Forests in Ukraine: Challenges and Solutions. *Grassroots Journal of Natural Resources*, 8(3): 469-497. Doi: https://doi.org/10.33002/nr2581.6853.080319

Received: 04 September 2025
Reviewed: 16 October 2025
Provisionally Accepted: 01 November 2025
Revised: 13 November 2025
Finally Accepted: 17 November 2025
Published: 31 December 2025
Copyright © 2025 by author(s)

Publisher's Note: We stay neutral with regard to jurisdictional claims in published maps, permissions taken by authors and institutional affiliations.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/

Open Access

Executive Chief Editor
Dr. Hasrat Arjjumend
Assistant Managing Editor
Mr. Kartik Omanakuttan
Associate Editors
Dr. Usongo Patience
Dr. Nivedita Chaudhary
Pramod Ghimire

Abstract

This article examines the unprecedented impact of the Russian Federation's armed aggression against Ukraine on the country's forest resources and forest management system. The war has caused large-scale and multidimensional losses, including damage to approximately three million hectares of forest, among them unique protected areas, widespread contamination by explosive ordnance, soil degradation, biodiversity loss, and a substantial reduction in ecosystem services, estimated at US$250 billion per year. Using an integrated approach that combines legal analysis, ecological damage assessment, and policy review, the study identifies critical gaps in Ukraine's forestry legislation. In particular, the Forest Code of Ukraine lacks legal categories such as "forests damaged by military operations" and "forests destroyed by military operations." This omission complicates the accounting of war-related losses, the establishment of special management regimes, and the inclusion of environmental damages in international reparation claims. The analysis highlights the challenges posed by large-scale wildfires, mine contamination, infrastructure destruction, and workforce shortages that hinder post-war forest recovery. To address these challenges, the article proposes a framework for post-war reform, including the creation of a national legal regime for war-affected forests, the development of methodologies for quantifying and monetizing ecosystem service losses, and the adoption of a unified national forest restoration strategy aligned with international environmental commitments. It also emphasizes prioritizing demining in ecologically valuable areas, applying advanced technologies, such as satellite monitoring, unmanned aerial vehicles (UAVs), and artificial intelligence (AI), and securing sustainable financing through national and international channels. The findings contribute to the formulation of a comprehensive model for rebuilding Ukraine's forestry sector and provide valuable insights for the international community on restoring natural resources and ecosystem services in post-conflict environments.

Keywords

War-damaged forest; Legal regime of forests; Ecosystem services; Forest losses; Forest restoration

Doi: https://doi.org/10.33002/nr2581.6853.080319 Open Access

Introduction

Ukraine's forests are not merely sources of timber or recreational areas. They are a complex, multifunctional ecosystem that regulates the climate and water balance, preserves biodiversity, purifies the air and water, protects the soil from erosion, and provides numerous ecosystem services that ensure the well-being of society. According to the State Forestry Agency of Ukraine (2023), forest cover amounts to 15.9% of the country's territory, below the European average of approximately 20%, and varies markedly by region (51.4% in Zakarpattia Oblast vs. 3.7% in Zaporizhzhia Oblast) (Basic Principles Strategy, 2019).

The Russian Federation's armed aggression—beginning in 2014 and escalating to full-scale war in 2022 — has inflicted catastrophic damage on Ukraine's forest ecosystems. Approximately three million hectares — nearly one-third of Ukrainian forests—have been affected; 690,000 hectares require demining, and over 500,000 hectares remain under occupation or active hostilities (Biznes Censor, 2023). The destruction of the Kakhovka Hydroelectric Power Plant (June 2023) flooded more than 55,000 hectares of forest — 47,000 hectares of which lie in occupied territories — constituting one of Europe's most severe recent environmental disasters[1].

War has a multifaceted impact on forest ecosystems. This includes not only the physical destruction of trees due to shelling, fires, the construction of fortifications, or the passage of military equipment, but also the destruction of habitats, soil degradation, toxic contamination, mine hazards, reduced recreational potential, and loss of ecosystem services. According to expert estimates, the annual value of ecosystem services provided by Ukrainian forests is US$250 billion (Tkach *et al.*, 2023). Their loss poses long-term threats to the ecological, economic, and food security of the state.

The problem of Ukraine's war-damaged forests is not only of national but also of global importance. The mountain pine forests of the Ukrainian Carpathians and the sub-Mediterranean forests of Crimea are included in the World Wildlife Fund's (WWF) list of 200 global ecoregions. Ukraine has 12 UNESCO World Natural Heritage sites, classified as "Primeval Beech Forests of the Carpathians and Other Regions of Europe." Their total area is about 29,000 hectares, and the buffer zone corresponds to 43,000 hectares around the UNESCO heritage sites. In addition, the International Union for Conservation of Nature (IUCN) has recognized the Crimean Mountains as one of the world's centers of plant diversity (Poliakova and Abruscato, 2023).

Several Ukrainian forests are included among WWF global ecoregions, and certain areas — chiefly the Carpathian beech forests (inscribed in 2007), hold UNESCO World Heritage status (UNESCO, 2017). The destruction of these territories violates Ukraine's international obligations under the Convention on Biological Diversity (1992) and the Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention 2003), contradicts the Sustainable Development Goals (SDG-15), and poses a threat to the planetary ecological balance.

[1] Digest of the key consequences of Russian aggression for the Ukrainian environment (May 25 – June 9, 2023). (2023). Ministry of Environmental Protection and Natural Resources of Ukraine. Available online at: https://mepr.gov.ua/dajdzhest-klyuchovyh-naslidkiv-rosijskoyi-agresiyi (in Ukrainian)

Despite these critical losses, Ukrainian legislation lacks explicit legal categories such as "forests damaged by military operations" and "forests destroyed by military operations". This legal gap hinders the systematic accounting of environmental damage, complicates restoration planning, and prevents the inclusion of ecosystem service losses in international reparation claims against the aggressor state.

Therefore, addressing the legal status of war-affected forests is not solely an environmental protection issue but a multidimensional challenge encompassing sustainable development, national security, and international law. Establishing these legal categories would create a foundation for (i) assessing ecosystem damage, (ii) prioritizing demining of ecologically valuable areas, and (iii) substantiating reparations claims. This study seeks to analyze these legal and ecological challenges and propose a comprehensive framework for reforming forest governance in post-war Ukraine.

Literature Review

An analysis of publications on the problems of the ecology of war demonstrates both the negative and, in certain aspects, the positive impacts of armed conflicts on biodiversity and the natural environment (Hanson *et al.*, 2009). This also applies to the intensity of deforestation, which may either increase or decrease depending on the specific complex socio-ecological dynamics associated with the conflict itself (Alvarez, 2003; Clerici *et al.*, 2020; Ordway, 2015; Reuveny, Mihalache-O'Keef and Li, 2010). Numerous ecological and social changes that occur during conflicts can generate new and significant sources of greenhouse gas emissions. At the same time, armed conflicts may also create opportunities for economic or social transformations that could contribute to a future reduction of emissions.

Protecting the environment and natural resources is considered a key element in transitions from armed conflict to peace (Clerici *et al.*, 2020; Gaynor, Davies and Fearnside, 2016). The issue of the legal status of forests damaged by war in Ukraine has become the subject of research in the scientific literature since its emergence. The armed aggression of the Russian Federation against Ukraine began on February 19, 2014, and escalated into a full-scale invasion on February 24, 2022, which continues to this day. Therefore, since 2014, the category of "war-damaged forests" has appeared in Ukraine, and since 2022, its quantitative scope has increased significantly. This problem is actively studied within legal scholarship as well as related disciplines.

With the introduction of martial law in Ukraine, as emphasized by Malysheva (2025), it became evident that environmental legislation, which had been designed for peacetime conditions, was not fully suitable for wartime realities. As a result, gaps in environmental law emerged, directly linked to new challenges. Thus, Sokolova (2009) concluded that a forest should be understood not as an independent natural object, but as an ecological system biogeocenosis, which should consist of several independent natural objects or parts thereof. Muravska (2013) uses the example of forests to consider ecosystems as a legal category under Ukrainian law. Suietnov (2020, 2023) emphasizes the need to implement "ecosystemization" of current environmental legislation, in particular the Law of Ukraine "On Environmental Protection" and all resource-related laws and codes,

defining the ecosystem as an object of legal protection at the legislative level and examining all natural objects and resources through its prism, with subsequent consideration of their ecosystem characteristics in legislation.

Suietnov argues that the situation that has developed with regard to Ukraine's forest ecosystems requires urgent and effective legal regulation aimed at their preservation, restoration, and management, with due regard to positive European experience. The scholar concludes that, as a result of the armed aggression of the Russian Federation, Ukraine's forest ecosystems have suffered and continue to suffer significant damage, and their restoration will require millions of hryvnias and several decades (Suietnov, 2022). The concept of "ecosystem services" was first introduced in 1973 by the British scholar E.F. Schumacher in his work *Small is Beautiful: Economics as if People Mattered* (Schumacher, 1973). The first description of the concept was provided in 1981 by Paul and Anne Ehrlich, who interpreted services as ecosystem functions utilized by society (Ehrlich and Ehrlich, 1981). Ecosystem services may be defined as "the set of ecosystem functions that are useful to humans" (Kremen and Cowling, 2005). They result from supporting processes that operate across different temporal and spatial scales (Farber *et al*, 2006). These general definitions have been widely used; however, the classification of services and the application of this system in decision-making reveal a number of uncertainties. In particular, the term "ecosystem services" carries different semantic meanings depending on the specific purpose (Fisher, Turner and Morling, 2009).

Kovtun (2023; 2024) stresses the necessity of introducing into national legislation the concept of ecosystem services, as well as the development of methodologies for their calculation. This would allow the inclusion, in the number of reparations that the Russian Federation will be obliged to pay Ukraine, of the value of ecosystem services that have been lost or not received (particularly those provided by forest ecosystems). The researcher also proposes ways to improve Ukrainian legislation on ecosystem services.

Overall, the reviewed literature underscores the convergence between ecological and legal perspectives on the impact of war on forests. However, despite significant scholarly progress, a clear and unified legal framework defining "forests damaged" and "forests destroyed by military operations" has yet to be institutionalized. This gap hinders systematic assessment, restoration planning, and the inclusion of ecosystem service losses in Ukraine's environmental and legal recovery strategies.

Methodology

This study employed a mixed-method qualitative and analytical approach, combining document analysis, legal evaluation, and empirical data assessment to examine the legal and ecological dimensions of war-damaged forests in Ukraine.

Stage 1: Collection and review of legal documents.

We conducted an extensive desk review to collect primary and secondary legal sources related to forest protection and environmental governance in Ukraine during wartime. These sources included the Forest Code of Ukraine, the Law "On Environmental

Protection", Cabinet of Ministers' resolutions, and presidential decrees issued between 2014 and 2025. International treaties and conventions such as the Bern Convention, the Convention on Biological Diversity, and the EU forest and environmental directives were also analyzed.

Stage 2: Compilation of empirical and statistical data.

We compiled data on forest damage, burned areas, and mine contamination from official sources, including the State Forest Resources Agency of Ukraine, the Ministry of Environmental Protection and Natural Resources, and international partners (UNDP, UNEP, WWF). These datasets were complemented by satellite-based reports from UNOSAT and ESA (European Space Agency) to verify spatial patterns of deforestation and degradation in conflict zones.

Stage 3: Content and comparative analysis.

The collected legal materials were systematically coded and categorized to identify legislative gaps and inconsistencies in the regulation of war-affected forests. We performed a comparative analysis of Ukraine's forest-governance framework against selected post-conflict countries — Croatia, Bosnia and Herzegovina, and Georgia – to identify restoration and demining practices potentially applicable to Ukraine.

Stage 4: Evaluation of environmental and governance impacts.

Empirical data were analyzed to quantify the extent of forest destruction, loss of carbon sequestration capacity, and damage to ecosystem services. Official statistics were cross-checked with reports from international environmental monitoring missions. Governance performance was evaluated through criteria such as institutional coordination, legislative adaptability, and integration of international environmental obligations.

Stage 5: Scenario development and validation.

Based on the analyzed data, three potential scenarios for forest restoration and legal adaptation were modeled: (a) baseline (minimal intervention), (b) moderate recovery with international assistance, and (c) accelerated restoration integrating digital monitoring tools such as drones and AI-based mapping. We solicited expert opinions from Ukrainian forestry officials and legal scholars via semi-structured correspondence to validate scenario feasibility.

This multi-stage approach ensured methodological rigor and transparency by combining legal document analysis, comparative legal research, and data-supported ecological assessment. The integration of qualitative and quantitative materials allowed for a comprehensive evaluation of war-related forest damage and the formulation of practical recommendations for policy and legislative reform.

Results And Discussion

Scale and New Dimension of Forest Losses in Wartime

The full-scale invasion of Ukraine by the Russian Federation has caused unprecedented ecological damage, transforming both the scale and nature of forest degradation. Before 2022, the main drivers of forest disturbance included illegal logging, accidental fires, and climate-induced drought. However, wartime impacts have introduced qualitatively new and more severe factors: direct combat damage, large-scale mining, destruction of rare habitats, and widespread contamination with explosives, heavy metals, and petroleum products.

The geographical distribution and specifics of forest resource losses during the war are uneven. The greatest damage due to active combat operations, namely: tens of thousands of hectares of coniferous forests destroyed or damaged, windbreak forest strips disrupted, high risk of repeated fires, dust, and storms. Spatial analysis of UNOSAT and ESA satellite imagery (2022–2024) indicates that eastern and southern regions — Donetsk, Luhansk, Kharkiv, Zaporizhzhia, and Kherson — account for over 70% of forest destruction attributable to active hostilities. Regional hotspots of forest loss were identified, and several ecologically significant territories suffered catastrophic losses:

- Kinburn Peninsula (the Kinburn Spit Regional Landscape Park, part of the Black Sea Biosphere Reserve and the Biloberezhzhya Svyatoslav National Nature Park): over 7,500 hectares of relict forest have been destroyed (Spit, 2025);
- The Chornobyl Biosphere Reserve – during the period of temporary occupation and hostilities in 2022, approximately 8,700 hectares of forest fires occurred (Regional Eastern Europe Center);

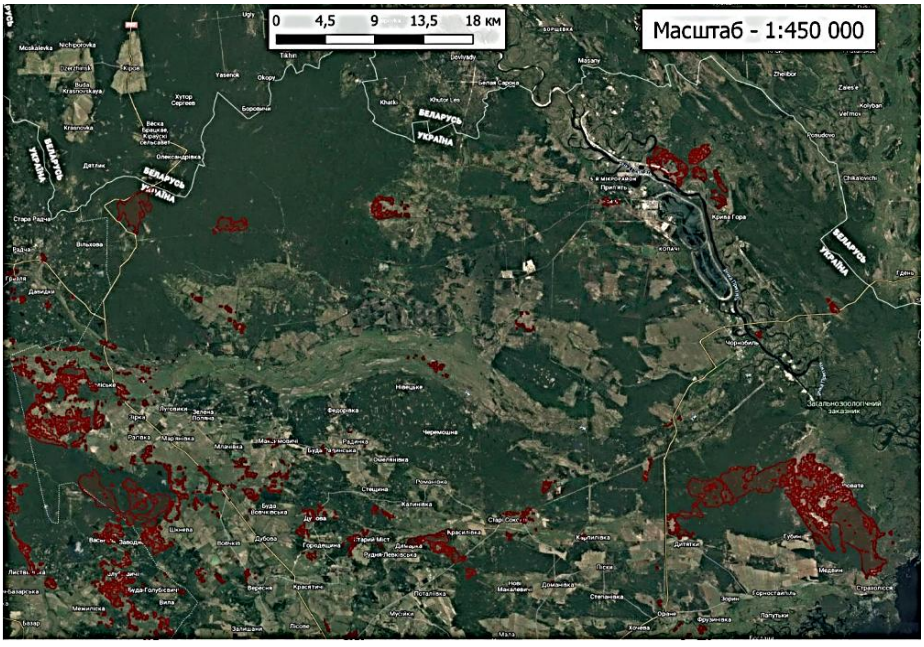

Figure 1: Spread of forest fires within the Chernobyl Exclusion Zone in 2022 (according to EFFIS data)

- Carpathian primeval forests and Emerald Network sites (some with UNESCO World Heritage status) face greater risk from secondary pressures — e.g., increased harvesting of firewood by displaced populations — than from direct combat in many cases.
- Kinburn Peninsula: Over 7,500 hectares of relict pine and oak forests were completely burned or destroyed within the Kinburn Spit Regional Landscape Park, which is part of the Black Sea Biosphere Reserve and the National Nature Park "Biloberezhzhya Svyatoslava" (Spit, 2025).
- Chornobyl Biosphere Reserve: During the occupation in 2022, approximately 8,700 hectares of forest were burnt, releasing substantial amounts of radionuclides into the atmosphere (Regional Eastern Europe Center, 2023).
- Carpathian Primeval Forests and Emerald Network Sites: While direct war damage was limited, indirect pressures such as unsanctioned wood harvesting for internally displaced persons (IDPs) led to a 20–25% increase in local forest extraction since 2022.

In addition to direct, visually apparent damage to forest resources, the war has triggered secondary and cumulative degradation processes that are not immediately apparent and currently remain unaccounted for, primarily soil degradation and biodiversity loss. Explosions that damage the soil cover are particularly dangerous, causing craters and destroying the micro-relief. The construction of fortifications and the destruction of hydraulic structures disrupt the hydrological regime and change water flow, affecting swampy forests and coastal ecosystems. This, in turn, leads to the degradation of a whole cascade of ecosystems: natural tree regeneration is lost, the species composition of vegetation changes, and rare species are displaced by aggressive invasive ones. In combat zones, there is a sharp decline in the number of birds and mammals. These losses are practically not taken into account in the existing statistics of the State Forestry Agency and are not included in financial assessments of damages (Public Forest Resources Agency Report, 2024).

Legal Status of Forests in Ukraine

Historically, Ukrainian forest legislation was rooted in a resource-oriented paradigm, emphasizing forest utilization with limited focus on conservation. However, a significant shift began with the adoption of the Law of Ukraine No. 2063-VIII (May 23, 2017), which introduced an ecosystem-based approach to forest governance. This transformation aligns with Ukraine's international commitments under the Convention on Biological Diversity (1992, ratified in 1994) and the Carpathian Convention (2003, ratified in 2004). Amendments to Article 1 of the Forest Code of Ukraine (2006)[2] reflect this paradigm change by redefining forests as ecosystems rather than merely resources: "A forest is a type of natural complex (ecosystem) that combines tree and shrub vegetation with corresponding soils, herbaceous vegetation, fauna, microorganisms, and other natural components that interact with each other in their development".

[2] Forest Code of Ukraine (as amended by Law No. 3404-IV of 08.02.2006). (2006). Bulletin of the Verkhovna Rada of Ukraine, No. 21, Art. 170. Available online at: https://zakon.rada.gov.ua/laws/show/3852-12#Text (In Ukrainian)

The ecosystem approach broadens the scope of legal regulation: forests are considered not only as an object of use (Table 1), but as a multifunctional system that provides ecosystem services: CO_2 absorption, climate regulation, biodiversity conservation, and soil protection.

Table 1: Main categories of forests (Forest Code, 2006).

Category	*Article*	*Brief description*
Forests for nature protection, scientific, historical, and cultural purposes	Art. 8	Highest level of protection; use is restricted or prohibited
Protective forests	Art. 9	Located in riparian zones, around settlements, felling for primary use is prohibited.
Recreational and health forests	Art. 10	Used for tourism and recreation; selective and sanitary felling permitted.
Exploitation forests	Art. 11	Largest share; forestry activities allowed according to forest management plans
Primeval, quasi-primeval, and natural forests	Art. 39^1	Special protection regime; felling and construction prohibited; minimal human intervention

These provisions reflect an attempt to reconcile economic interests with Ukraine's environmental and international obligations.

It should be noted that the concept of primeval forest, quasi-primeval forest, and natural forest appeared in the Forest Code of Ukraine in 2017 to regulate the process of their identification and establish a protection regime in accordance with the obligations under the Carpathian Convention and the approved "Criteria and Indicators for the Identification of Primeval Forests in the Carpathians," and with the assistance of the World Wildlife Fund WWF-Ukraine. The Forest Code defined environmental restrictions for sustainable forest management during logging and the establishment of buffer zones around the main areas where primeval forests, quasi-primeval forests, or natural forests are located. In 2017, amendments were also made to the Law of Ukraine "On the Natural Reserve Fund," and an additional subcategory "primeval forest natural monuments" was added. The methodology for determining forest areas as primeval forests, quasi-primeval forests, and natural forests was adopted by the Ministry of Environmental Protection and Natural Resources in 2018 (Poliakova and Abruscato, 2023).

Despite the extensive damage caused by the war to forests of all categories, Ukrainian legislation still does not distinguish between specific categories of forests that are particularly important during wartime: "forests damaged by combat operations" and "forests destroyed by combat operations." This legal gap complicates:

- the recording and inventorying of damage;
- the determination of a special legal regime (e.g., restricted access due to mine danger);
- the inclusion of losses of ecosystem services in reparations claims;
- the restoration of forests damaged by combat operations.

Main Problems of Forests Affected by Hostilities and Prospects for Forest Restoration

Even today, with military operations continuing, scientists are considering the restoration of forest ecosystems based on a systematic analysis of existing problems and their reflection in law. Among them, the most serious are the following:

1. Forest fires

Forest fires represent one of the most serious consequences of military operations in Ukraine. They cause complex, long-term damage to ecosystems and significantly alter soil and vegetation dynamics (Zhesniak and Bosak, 2024). Fires often arise both as collateral damage of warfare and as intentional tactical actions used by combatants to hinder enemy movement or visibility (Vasilyuk, Kolomytsev and Parkhomenko, 2022; Vasyliuk and Hubareva, 2025). The negative impact of fires on forests can last for decades, affecting soil fertility, its ability to retain moisture, and supporting microbial diversity. Restoring damaged soils requires a comprehensive approach that includes erosion control measures, fertility restoration, and reforestation. In Ukraine, scientists are focusing on creating sustainable, mixed forest plantations that are better able to withstand future fires and other stress factors. Although full soil restoration can take more than half a century, timely and proper implementation of restoration measures can significantly accelerate this process and improve the overall condition of forest ecosystems (Zhesniak and Bosak, 2024).

2. Contamination of forests with explosive objects, mine hazards, and demining problems

According to UNDP estimates, Ukraine is currently the most heavily mined country in the world: potentially 23 percent of its territory may be contaminated with landmines and unexploded ordnance. As of April 2025, the area of mined forest land in Ukraine reaches about 450,000 hectares (UNDP, 2023). In total, 2.9 million hectares of the Emerald Network, 17 wetlands of international importance, and 812 nature reserve sites are at risk of destruction (Ministry of Environmental Protection and Natural Resources of Ukraine, 2023). Mine contamination is a global environmental problem that transcends individual countries and regions, affecting the entire planet. Its far-reaching consequences include several key aspects:

- Damage to ecosystems, destruction of species habitats, and destruction of flora and fauna, which have a cumulative effect and impact global ecosystems;
- Toxic substances released during mine explosions contaminate soil and water resources, spreading far beyond the specific territory and affecting the quality of water and soil in large regions;
- The destruction of forests, meadows, and other natural areas due to mine contamination affects global climate processes, contributes to an increase in greenhouse gases in the atmosphere, leading to global warming and climate change.
- Complicating the implementation of international environmental initiatives to protect biodiversity and preserve forests and water resources.
- Impacting agricultural land, threatening food security not only locally but also globally (Botnarenko, 2024).

Forests have become one of the most difficult areas to clear of mines: thick layers of litter conceal explosive objects, and tree roots complicate the use of demining equipment. According to estimates by the Ministry of Environmental Protection and Natural Resources, the process could take decades. Recognizing the danger of mines even before the war in Ukraine escalated into a full-scale conflict, the Law "On Mine Action in Ukraine" was adopted in 2018. (Law of Ukraine, 2018).

According to this law, demining should only be carried out by special licensed bodies (national and international). The law also stipulates that practical demining activities in Ukraine are coordinated by the Demining Center of the Ministry of Defense of Ukraine (part of the State Special Transport Service) and the Humanitarian Demining Center of the State Emergency Service (Law of Ukraine "On Mine Action in Ukraine," Resolutions of the Cabinet of Ministers of Ukraine (2022) "On the Establishment of a National Body for Mine Action", "On the Approval of Rules for Marking the Danger of Mine-Explosive Objects - Consequences of War"), etc. (Poliakova and Abruscato, 2023).

In accordance with the International Mine Action Standards (IMAS) implemented in Ukraine, mine action measures are carried out within the scope of its authority by the Interregional Center for Humanitarian Demining and Rapid Response of the State Emergency Service of Ukraine (Order № 230 of August 8, 2016). The recommendations of WWF-Ukraine's forestry experts on forest demining are as follows:

- Identify all forests with unexploded ordnance and develop special maps indicating dangerous areas.
- Inform forestry workers and the civilian population about the existence of such forests.
- Carry out demining work in forests where such measures are possible. The procedure for work in such areas must be agreed with the territorial body of the State Emergency Service of Ukraine and representatives of the Armed Forces of Ukraine.
- Restrict or prohibit access to forests where demining is completely impossible for the civilian population and forestry workers.
- At the legislative level, grant a special category to forests contaminated with ammunition and establish exclusion zones on their territories (Open Dnister, 2023).

3. Restoration of Ukrainian Forests of Special Conservation Value

According to the Ministry of Environmental Protection and Natural Resources of Ukraine (2023), 20% of Ukraine's nature reserves have been affected by the war, which corresponds to almost 1 million hectares, including occupied and de-occupied territories. Some occupied territories of international importance are still under threat, for example, 16 Ramsar sites (600,000 hectares of wetlands of international importance and rare species of plants and animals are under threat of destruction in Ukraine, 600 species of animals and 750 species of plants and fungi), 160 Emerald Network sites (corresponding to an area of 2.9 million hectares). Russian invaders still occupy 10 national parks, 8 nature reserves, and 2 biosphere reserves throughout Ukraine (Poliakova and Abruscato, 2023).

The temporary occupation of a significant part of the territory with particularly valuable forests, as well as the scale of hostilities, does not allow for a clear and complete assessment of the damage caused to forest nature conservation areas. Some of the protected areas and objects of the nature reserve fund are still located in the combat zone or in temporarily occupied territory, where economic activity has been suspended (for example, the Kreminski Forests National Nature Park in Luhansk Oblast) and it is not possible to inspect them (in Donetsk, Luhansk, Zaporizhzhia, Mykolaiv, Kherson, and Kharkiv regions). In the deoccupied territories, the extent of damage caused to forest nature conservation areas can be clearly determined after these territories have been demined (Poliakova and Abruscato, 2023).

Specifically: forest fires caused by shelling and bombing of valuable relict forests on the Kinburn Spit in the Mykolaiv region destroyed 4,780 hectares of relict forests; the destructive consequences of this have affected the habitat of approximately 100 species of birds and the welfare of animals (due to explosions, flashes of light, the passage of heavy equipment, etc.); in the Drevlyansky Reserve in the Zhytomyr region, more than 2,000 hectares of quasi-primeval forests were destroyed by fires (Poliakova and Abruscato, 2023).

One of the problems specific to Ukraine is that, unlike most European countries, the war in Ukraine has affected the forests in the exclusion zone around the Chornobyl Nuclear Power Plant, which have a special status introduced by Decree of the President of Ukraine No. 174/2016 of April 26, 2016: within the exclusion zone and the zone of unconditional (mandatory) resettlement in two districts of the Kyiv region that were contaminated by radiation as a result of the Chornobyl disaster, the Chornobyl Radiation and Ecological Biosphere Reserve (n.d.)[3] was created with a total area of 226,964.7 hectares (President of Ukraine, 2016). The legal regime of the relevant zones provides for significant restrictions on any interference with natural processes. This creates a unique legal situation: the forest needs to be restored, but any economic activity is prohibited by law.

4. Lack of a regulatory and methodological framework for accounting for ecosystem service losses

According to research conducted in the EU, forests and forest lands are the largest providers of ecosystem services (about 48% of the total value of ecosystem services provided by terrestrial and aquatic ecosystems in the 28 countries of the European Union). Their value in 2012 prices was estimated at €81.4 billion for the 28 EU countries, with the largest contributions coming from recreation, water protection and conservation, timber supply, and carbon sequestration services (Tkach *et al.*, 2023).

For a long time, the traditional principle of regulating the use of natural resources in Ukraine has been resource-based, taking into account only direct economic damage (wood, damaged equipment) (Malysheva, 2018). This approach takes into account the

[3] Chornobyl Radiation and Ecological Biosphere Reserve (n.d.). Available online at: https://wownature.in.ua/oberihaymo/biosferni-rezervaty-v-ukraini/chornobylskyy-radiatsiyno-ekolohichnyy-zapovidnyk/ [accessed on 22 October 2025]. (in Ukrainian)

proportional reduction of the forest fund but does not consider the loss of essential ecological functions previously provided by the forest. The following factors are often overlooked:

- loss of the ability of forests to absorb CO_2,
- reduction of the water conservation role,
- loss of biodiversity,
- destruction of recreational value,
- some other factors.

The most common interpretation of ecosystem services today is that proposed in the IEA report (2005): "the benefits that people receive from ecosystems." The TEEB approach (Gowdy, Howarth and Tisdell, 2010) defines ecosystem services as the direct or indirect contributions of ecosystems to human well-being. A similar interpretation is enshrined in the formulation of the Common International Classification of Ecosystem Services (CICES), launched in 2010 in collaboration with the United Nations Statistics Division and the European Environment Agency. In the CICES reports (2012), in-use ecosystem services are considered as "the contribution that ecosystems make to human well-being."

The International Classification of Ecosystem Services (CICES) version 4.3 (Czúcz *et al*., 2018) defines three main categories of ecosystem services: 1) provisioning services – services from products provided by ecosystems: food, water, wood, fiber, fuel, genetic resources, drinking water; 2) regulating services – services provided by regulating ecosystem processes: climate formation, protection from floods and other natural disasters, disease control, absorption of human waste, water and air purification, pest control; 3) cultural services – the contribution of ecosystems to the enrichment of the cultural, spiritual, and aesthetic aspects of human well-being.

Over time, the concept of ecosystem services has evolved and diversified, with scholars and policymakers recognizing the intricate linkages between natural systems and human societies. As understanding has deepened, various frameworks have emerged to categorize these services—most notably provisioning, regulating, cultural, and supporting services. The provisioning services encompass the tangible goods forests provide, such as timber, non-timber products, and raw materials essential for livelihoods. Regulating services, on the other hand, refer to how forests moderate environmental conditions through processes such as carbon sequestration, water purification, and climate regulation. Cultural services speak to the non-material benefits people derive from ecosystems, such as recreation, spiritual enrichment, and educational opportunities.

This broadening perspective has highlighted the necessity of integrating ecosystem services into national and regional decision-making. The adoption of international standards and classifications reflects a growing consensus on the value of these contributions—not just economically, but in terms of human well-being and environmental resilience (Tkach *et al.*, 2023).

In recent years, another category of such services has also become widespread—supporting services, namely services that ensure basic ecosystem processes: soil formation, primary productivity, basic biogeochemical processes (nutrient cycling, photosynthesis), and habitat (Soloviy, 2020). Not all ecosystem services have market

value and can be monetized (Vasyliuk *et al.*, 2023). In particular, it is impossible to monetize regulatory services. Such ecosystem services include all the diversity of processes in ecosystems that form the habitat of biological species, including humans. These include climate regulation, weather conditions, air quality, fresh water quality and quantity, soil formation, plant pollination, and a large number of processes that can be loosely referred to as the "natural balance". Ecosystem services that the Ukrainian people have been deprived of as a result of Russia's armed aggression must become a mandatory component of the reparations to be paid to Ukraine by the aggressor state. For example, if a forest is mined, some of the provisioning and socio-cultural services will be lost, as the biotope will be inaccessible to visitors and cannot be used for recreation, spending time in nature, picking mushrooms and berries, hunting, etc. However, the forest will continue to perform the vast majority of its regulatory services. Another thing is that if the forest is destroyed (by fire, explosions, artillery shelling, etc.), it completely loses its ability to be a source of ecosystem services (Vasyliuk *et al.*, 2023).

In general, when determining the amount of damage to the environment caused by the Russian Federation's terrorist attack on Ukraine, the following should be taken into account: 1. Current direct economic damage due to the destruction of natural resources and direct threats to public health due to environmental pollution; 2. Long-term consequences of environmental damage; 3. Impacts on neighbouring landscape ecosystems; 4. Loss of ecosystem services at the time of the violation and during the time required for the ecosystems to recover; 5. Costs of restoring the natural state of the ecosystem (Khomiak, 2023).

There is an urgent need today to adopt the Law of Ukraine "On Ecosystem Services" and its implementing regulations. It is also necessary to create a National Register of Ecosystem Services (state and local) with open access for the public. Such a register can, of course, be created provided that methods for the economic assessment of provisioning, regulating, supporting, and cultural ecosystem services are developed and implemented (Shpyliova and Nosulich, 2020).

5. Staff shortages and the destruction of forestry infrastructure

Since the start of the full-scale invasion of Ukraine, a significant number of forestry specialists have been evacuated or mobilized into the Armed Forces, and there is a shortage of new personnel. raining new forest-restoration specialists during wartime is challenging. In areas of combat operations, forestry operations have been destroyed or closed, forest roads, special equipment, and planting material warehouses have been destroyed or damaged. Serious damage and destruction of real estate and equipment hinder the recovery of the forestry sector in the medium and long term due to limited financial resources in the state budget. This situation also affects the ability to digitize the relevant sector. Several forestry enterprises in the east and south have lost their archives and forestry documentation. Destruction of the Ukrainian State Forestry Design and Production Association (VO "Ukrderzhlesproekt") has impeded timely revisions to forest management plans and the assessment of associated losses — critical steps for initiating restoration. VO "Ukrderzhlesproekt" was established based on Order No. 119 of the Ministry of Forestry of Ukraine dated September 30, 1991, to conduct forest management throughout Ukraine, which includes a set of measures aimed at ensuring

the effective organization and scientifically sound management of forestry, conservation and protection, rational use, improving the ecological and resource potential of forests, the culture of forest management, and obtaining reliable and comprehensive information about Ukraine's forest fund (Ukrderzhlisproekt, n.d.).

6. Problems of creating a unified State strategy for forest restoration

The central strategic document defining forest policy in Ukraine is the State Forest Management Strategy until 2035, approved by the Cabinet of Ministers on December 29, 2021 (№ 1777-r), before the full-scale invasion (State Forest Strategy until 2035, 2021). In September 2023, damage to forestry from Russian aggression was formally recognized as a key strategic issue. The Strategy's expected outcomes now include the restoration of forests damaged or contaminated by explosives and the rehabilitation of affected ecosystems. In line with the Strategy's objectives, a reform of the forestry sector has been launched, with the aim of ensuring sustainable forest management adapted to climate change, preserving biodiversity, and introducing effective environmental and economic mechanisms for forest management. The reform is expected, among other things, to contribute to positive environmental effects, such as increasing forest cover to at least 18% and ensuring Ukraine's contribution to the fight against climate change by increasing carbon sequestration by forests. In order to implement the reform, several regulatory acts were adopted at the level of the Cabinet of Ministers and relevant ministries.

An important direction of reforming the industry was administrative reform, which was initiated by the adoption of the Cabinet of Ministers Resolution "Certain Issues of Reforming the Management of the Forestry Sector" (Cabinet of Ministers of Ukraine, 2022).

Under the terms of the reform, nine regional forestry and hunting offices were established to replace the 24 regional offices of the State Forestry Agency. At the same time, 158 forestry enterprises were merged into a single state-owned specialized forestry enterprise, "Forests of Ukraine". Important results of the reform include a reduction in the administrative apparatus, a transition to automated and digitized management processes, a reduction in administrative personnel costs, simplification of administrative procedures, and others. At the same time, experts note significant shortcomings in the course of the reform. In particular, the consolidation of economic and management structures was carried out mechanically, rather than being aimed at eliminating the main problems of the industry, primarily corruption and the combination of economic and control and regulatory functions in one hand. The newly created state-owned enterprise "Forests of Ukraine" is under the management of the State Forest Resources Agency, whose functions have not changed and whose main activities include forestry, hunting, forest protection and restoration, as well as the state hunting fund on the territory of hunting grounds used by the state-owned enterprise "Forests of Ukraine".

The consolidation of forestry enterprises also took place formally, as 146 former enterprises were transformed into 146 branches of the State Enterprise "Forests of Ukraine". Taking into account the risks of corruption, Ukraine's anti-corruption bodies (the National Agency for Corruption Prevention and the Specialized Environmental

Prosecutor's Office), together with the Basel Institute on Governance and the World Wildlife Fund, conducted a comprehensive analysis of corruption risks in the forestry sector, identified the most common ones, and formulated recommendations for their minimization/elimination (Basel Institute on Governance, 2025). As a result, it was found that forestry remains one of the most corrupt and vulnerable sectors in Ukraine, with the main problems being insufficient control, conflicts of interest between economic and regulatory functions, imperfect legislation, and a low level of data updating.

It should be noted that the war in Ukraine has significantly complicated the situation in the forestry sector, causing damage to a significant part of the forests and an increase in demand for timber both domestically and abroad. The fifth package of EU sanctions against Russia included a ban on timber imports from the aggressor country. In response, Ukraine began to increase logging volumes in order to partially replace Russia and Belarus on European timber markets. At the same time, the moratorium on temporary inspections of economic entities under martial law, the cancellation of the so-called "silent season" for the same period, i.e., the ban on logging in forests from April to June (during the animal breeding season), created conditions for abuse and illegal logging. Abuse of discretionary powers by forest users, manipulation of permits, and artificial obstacles to proper supervision undermine environmental safety, cause significant damage to the state budget, and contribute to the uncontrolled use of valuable natural resources. Therefore, the ongoing reform of the forestry sector focuses on the unification of legal norms, the introduction of independent supervision, the digitization of accounting processes, and transparent procedures, which are critical for overcoming corruption risks. To achieve real change, it is necessary to create a clear, comprehensive strategy that includes both legislative reforms and institutional transformations. It is important to increase the accountability of state bodies and introduce effective mechanisms of public control that will make it possible to protect Ukraine's forest resources and ensure their sustainable development and the well-being of present and future generations (Basel Institute on Governance, 2025). We believe that it is also critically important for the organization of forest restoration to strategically prioritize forest areas subject to restoration and to improve the legislative framework for determining the criteria for priority forest restoration: ecological value or economic feasibility.

Innovative Technologies in Accounting and Restoration of War-Damaged Forests: Transformation of approaches to accounting and monitoring

The full-scale armed aggression of the Russian Federation has significantly changed approaches to accounting, monitoring, and restoration of forests in Ukraine. The traditional approach to forest inventory in Ukraine, which relied mainly on field surveys and the collection of statistical data by forestry specialists and scientists, proved to be practically unusable in conditions of combat operations, mine danger, and destruction of roads and infrastructure. Therefore, it was the war that became the catalyst for the active introduction of innovative digital technologies that enable real-time monitoring and planning of forest restoration with minimal risk to people. Among the information technologies that began to be actively implemented in Ukraine during the war to monitor

and assess damaged and destroyed forests and plan reforestation work, the following stand out:

1. *Remote sensing of the Earth from outer space* using satellite technologies (RS) – Satellite images obtained, in particular, through the EU Copernicus program, which Ukraine joined in April 2025[4], from Sentinel (NULES of Ukraine, 2023) and Landsat (USA) (Landsat Image Gallery, n.d.) satellites, make it possible to observe large areas in dynamics; detect new fire outbreaks; assess changes in the green index (NDVI) and other indicators of vegetation condition. Space technologies offer open-source data availability and frequent temporal updates.

2. *Use of unmanned aerial vehicles (UAVs)* for high-resolution local mapping – UAVs enable high-precision images of forest areas to be obtained with a resolution of up to several centimeters. These technologies make it possible, in particular, to determine the extent of damage without risk to people, assess the types and degree of forest damage, and predict further developments (e.g., the risk of new fires or erosion). This is particularly valuable for assessing minor damage that is not recorded by satellites; monitoring the condition of individual relic or rare trees; and planning local restoration work (creation of micro-nurseries, planting of species). A notable example is the WWF-Ukraine pilot project in the Chornobyl Radiation and Ecological Biosphere Reserve (n.d.), which employs UAVs to map areas affected by secondary fires and to identify zones requiring urgent human intervention.

3. *Involvement of artificial intelligence (AI) and automated data processing algorithms* – AI is used in forest monitoring in Ukraine to automatically recognize types of damage (fires, explosions, construction), predict risks (probability of new fires, spread of pests), and model restoration scenarios (e.g., optimal tree composition) (Francisco, 2023). International experience in using relevant algorithms to map mine hazards in forests (Bosnia and Herzegovina Mine Action Centre) is currently being studied. The use of AI in forest restoration has a number of advantages. In particular, machine learning models can predict the further development of environmental disasters, which makes it possible to better plan measures to eliminate the consequences of military actions and restore destroyed ecosystems. Such forecasts can be useful for predicting future environmental risks (Filipchuk and Tkachuk, 2024). AI-based systems are also capable of tracking the rate of deforestation, detecting illegal logging, which is often carried out by occupying forces, and assessing its impact on biodiversity and climate. The use of such systems allows for the monitoring of ecosystem restoration, assessing the effectiveness of measures to rehabilitate the territory after environmental disasters caused by military operations. Thanks to the accurate analysis of the data obtained, strategies can be developed to improve the environmental situation in territories liberated from occupation (Artificial Intelligence).

4. *Digital platforms and open data* – Development of national geoportals. One of the most notable platforms, in particular, was introduced as part of the project "Creation of an interactive online platform for mapping war-related damage, with classification of

[4] See: Ukraine Joins the EU Space Program: What It Means. (2023). Retrieved from https://texty.org.ua/fragments/114862/ukrayina-pryyednuyetsya-do-kosmichnoyi-prohramy-yes-shho-ce-oznachaye

destroyed objects by type and degree of damage in 20 pilot communities using geographic information systems" with the assistance of the United Nations Development Programme (UNDP) in Ukraine within the framework of the Peacebuilding and Recovery Programme with financial support from the European Union (UNDP, 2023). Among the types of objects whose degree of destruction is subject to assessment, the platform separately highlights forest fund objects, namely: losses and damage to forests and forest areas, and related losses. Such platforms make it possible to combine different types of data (satellite images, field data, UAVs), provide open access for scientists, the public, and international partners, and increase the transparency and quality of assessments.

5. *Electronic timber accounting and digital forestry permits* – In accordance with Resolution No. 625 of the Cabinet of Ministers of Ukraine (2025), "On the implementation of a pilot project for the issuance of certain forestry permits in electronic form", (Cabinet of Ministers of Ukraine, 2025). Resolution No. 625 of May 30, 2025, a pilot project has been launched for the issuance of certain permits in the field of forestry, namely logging tickets and certificates of origin for timber and sawn timber products, in electronic form through the EcoSystem unified environmental platform. "In fact, for the first time in Ukraine's history, we have created a comprehensive digital chain for tracking the movement of timber from harvesting to export. This is one of the reasons why the European Commission has classified Ukraine as a low-risk country under the European Union Deforestation Regulation[5].

Benefits and Challenges

In general, the use of new innovative technologies for forest restoration reduces risks to people, as it allows environmental changes to be monitored remotely instead of sending experts to dangerous areas, which significantly enhances the safety of environmental monitoring in armed conflicts. In addition, process automation significantly speeds up the time it takes to obtain results and allows for more efficient use of limited resources (Filipchuk and Tkachuk, 2024). However, several challenges persist. High financial costs for acquiring and maintaining equipment, software, and cloud infrastructure remain a significant barrier. There is also a severe shortage of qualified specialists capable of processing large spatial datasets and managing analytical algorithms. Additionally, legal ambiguities, particularly regarding UAV use in border zones or combat areas, limit the application of these technologies precisely where they are most needed.

Despite these difficulties, Ukraine's experience is already becoming a unique example for other countries. The use of UAVs, satellite imagery, and artificial intelligence in the context of military conflict not only provides new data but also shapes a new methodology for assessing ecosystem damage, which can be used to prepare compensation claims and justify the need for international financial assistance. The above gives grounds for concluding that the use of new innovative technologies for forest restoration reduces risks to people, as it allows environmental changes to be monitored

[5] EUDR Country Classification List. An official website of the European Union. Available online at: https://green-forum.ec.europa.eu/nature-and-biodiversity/deforestation-regulation-implementation/eudr-cooperation-and-partnerships/country-classification-list_en

remotely instead of sending experts to dangerous areas, which significantly enhances the safety of environmental monitoring in conditions of armed conflict. In addition, process automation significantly speeds up the time it takes to obtain results and allows for more efficient use of limited resources.

Foreign Experience for Ukraine

While no single European or global precedent fully addresses the legal regulation and restoration of war-damaged forests, elements from post-conflict forest management and mine-action frameworks offer useful lessons. A key example is Croatia, which, after the 1991–1995 war, enacted a specific Humanitarian Demining Act. This law defined the procedures for clearing mines in various territories, including forested areas, and established a mechanism for classifying them as "war-damaged." Such classification enabled the prioritization of demining ecologically significant zones and efficient allocation of resources[6].

The legislation on mine action and demining developed and implemented in Bosnia and Herzegovina is interesting for Ukraine to study and possibly borrow certain elements from. Mine action began here with the active support of international organizations, primarily with the establishment of the UN Mine Action Center in 1996, as well as the launch of special World Bank programs. Demining activities were recognized as a key prerequisite for the restoration of natural ecosystems and economic activity, as well as the return of refugees. Therefore, in 2002, the Demining Act was adopted, and the Mine Action Center was established under the Ministry of Civil Protection. It is important to note that all demining activities in Bosnia and Herzegovina were carried out on the basis of strategic documents. Since 2002, two state strategies for mine action have been implemented: for the periods 2002-2009 and 2009-2019. At the same time, as the strategy was implemented, it was reviewed and refined in line with the assessment of current strategic and operational goals, financial and resource plans, and the overall assessment of the mine problem. Three priority categories were identified (Bosnia and Herzegovina Mine Action Strategy, 2009).

In Bosnia and Herzegovina, monitoring systems—supported initially by NATO/SFOR and then by regional demining centers—collected information on mined areas and environmental impacts (destroyed forests, damaged topsoil, reserve sites), which informed demining plans. The same information is recorded by the regional demining centers, RSMAC and FMAC. After that, information about mined areas is forwarded to the competent authorities for the conclusion of a demining plan. Since the start of technical surveys and demining operations in Bosnia and Herzegovina from 1996 to 2020, 69,202 anti-personnel mines, 8,554 anti-tank mines, and 61,456 unexploded ordnances have been found and destroyed. The area of potentially dangerous mined land in BiH as of 2020 was 956.36 km2, or 1.96% of the total area of Bosnia and Herzegovina, meaning that during the period of the Demining Law (since 2002), this figure has been reduced by more than half (Vysotska, 2022). These data indicate that it will take some time to restore sustainable forest management in both state-owned and municipally-

[6] See: Final Proposal of the Humanitarian Demining Act (2016). Available online at: https://vlada.gov.hr/UserDocsImages//2016/Sjednice/Arhiva//128-3.pdf (In Croatian)

owned forests. First of all, forest areas near populated areas, as well as those where forestry activities are actively carried out, will be subject to demining. The issue of demining remote forest areas, areas that have been located along the demarcation line for a long time, and occupied territories will remain acute. Linear protective plantations, particularly along roads and fields, and ravine and gully plantations, are most affected by military operations and will remain areas with a high risk of explosion for the longest time. This is also because the land under such plantations has not been transferred for use.

The experience of Bosnia and Herzegovina, as well as Croatia, demonstrates that demining activities are very time-consuming, financially costly, and technologically complex. In this regard, Ukraine should also study the experience of these countries in terms of the broad involvement of international and foreign financial and technological assistance. The Mine Action Strategy adopted in Bosnia and Herzegovina on April 24, 2008, was initially designed for the period 2009-2019, but was actually implemented until 2025. According to this Strategy, territories (including forests, which were not subject to separate regulation in the Strategy) damaged by combat operations and mine hazards are subject to special registration and zoning. It is important to note that the Strategy gave top priority to the demining of nature conservation areas (Bosnia and Herzegovina Mine Action Strategy, 2009).

In terms of strategic planning for forest restoration, Ukraine may find the experience of the so-called “buffer zone” of Cyprus useful, where, since 1974, for 40 years, the territory was divided along ethnic lines between the Greek Cypriot and Turkish Cypriot communities. The comprehensive forest restoration of Cyprus’s buffer zone may serve as an example of organizing the preservation of forest ecosystems and the socio-ecological landscape, combined with the productive use of forest territory (Constantino and Eftychiou, 2017). The Forest Restoration Action Plan developed here in 2023 was focused on integrated management and encouraging community participation through education and joint planning to address urgent problems: reducing fire risks, soil erosion, and increasing biodiversity (Athanasiou, 2023).

Given the limited financial and other resources in war-exhausted Ukraine, the experience of broad involvement of international organizations, primarily the UN system, in forest restoration is of particular interest. Thus, it is worth analyzing the experience of the UN Climate Change Programme, which in 2023 launched the Forest Restoration and Sustainable Development Programme in the Pomac Reserve, Peru. This reserve possesses the world’s largest stocks of carob trees and includes over 90 species of birds and plants, but it found itself in a state of serious ecological degradation as a result of years of plundering by land speculators, illegal settlers, and loggers. The UN Programme succeeded in involving not only rural communities living in the buffer zone of the reserve but also volunteers and students from around the world in the implementation of the program, while carrying out systematic monitoring of restoration. Interestingly, during implementation, through interaction among state, public, and private organizations, the project expanded to include training of local communities in environmentally sustainable activities, including those related to ecotourism (UNFCCC, n.d.).

For Ukraine, these international experiences underscore the need to combine legal reforms, institutional coordination, and broad international cooperation to address post-war forest recovery. Ukraine's progress with national projects and partnerships — such as with WWF-Ukraine, the Ministry of Environment, and UNEP — demonstrates a growing foundation upon which foreign best practices can be adapted to national realities.

Conclusions, Recommendations and Vision of Reform

Large-scale forest destruction from armed aggression has created unique legal and practical challenges without direct analogues in 21st-century Europe. The war has inflicted multilayered damage on forest ecosystems: from the destruction of forest tracts and the devastation of infrastructure to invisible but no less significant losses such as soil degradation, biodiversity decline, and the loss of ecosystem services. Analysis of the current legislation of Ukraine demonstrates its significant development toward the ecosystem approach, especially after amendments to forest legislation in 2017, but at the same time reveals a systemic gap – the absence of special legal categories of "forests damaged by hostilities" and "forests destroyed by hostilities". This prevents: the comprehensive accounting of such territories; establishing a special regime of use (in particular, due to mine danger); and substantiating the inclusion of ecosystem service losses in international reparation claims.

Comparisons with Croatia, Bosnia and Herzegovina, and Cyprus show that wartime legal definitions and special regimes are feasible and necessary for effective reconstruction and for mobilizing international assistance. Based on the conducted research, it is advisable to propose the following key recommendations that should be included in the forest legislation of Ukraine:

1. Amend the Forest Code to define and codify "forests damaged by hostilities" and "forests destroyed by hostilities", incorporating an ecosystem approach. Include procedures for recording such forests, special use regimes (e.g., restricted access), and demining and restoration protocols. Such consolidation should include: definition of the concept; procedure for recording forests damaged by hostilities; peculiarities of use (including restricted access); establishing a demining regime and other measures for restoring damaged forests.
2. Create methodologies for assessing and monetizing losses of ecosystem services, including, in particular, carbon absorption, recreational potential, and biodiversity conservation functions. These methodologies should form the basis for reparation claims and economic planning.
3. Prioritize demining of forests with the highest ecological value, such as primeval forests, protected areas of the Emerald Network, and beech primeval forests of the Carpathians.
4. Institutionalize the use of innovative technologies – UAVs, satellite technologies, artificial intelligence systems – through the creation of a national platform for monitoring and recording forest damage.
5. Form a unified state strategy for the restoration of forests damaged by war, taking into account the ecological, economic, and social components, as well as Ukraine's international obligations (in particular, under the Convention on Biological

Diversity, the Carpathian Convention, and the UN Sustainable Development Goals).

6. Ensure sustainable financing mechanisms, including national programs, international aid, and specialized funds such as the Environmental Recovery Fund of Ukraine.

In the long term, the reform should reflect the transition from a resource management model to an ecosystem-based one, where the forest is viewed not as a source of timber, but as a multifunctional natural system performing critically important functions at national and global levels. Thus, the Ukrainian experience of conserving and restoring forests in wartime conditions is already becoming an example for international practice. Successful implementation of the proposed changes can not only restore national natural wealth but also create a legal model for protecting natural resources in conflict regions of the world. We support the expert proposal to grant, at the legislative level, a special status to forests contaminated with munitions and to establish an exclusion zone on their territory. Even under the legal regime of martial law (first introduced by the Decree of the President of Ukraine No. 64/2022 of February 24, 2022, and subsequently extended several times), Ukraine adheres to its European integration course. Therefore, Ukraine's forest policy must be aligned with European forest policy, in particular with the EU Biodiversity Strategy for 2030, the EU Forest Strategy for 2030, the EU Nature Restoration Law, and the EU Regulation on deforestation and forest degradation (EUDR), among others.

The Forest Code of Ukraine, adopted back in 1994 and updated in 2006, does not fully correspond to all modern challenges, such as forest management reform, digitalization of the forestry sector, the need for forest restoration in de-occupied territories, and many others. That is why the Code needs updating and harmonization with EU legislation. First of all, this concerns updating approaches to forest management. In particular, it is necessary to introduce the norms of forest management based on principles close to nature. It is also important to implement the principles of the European Green Deal and the European EUDR regulation, ensure traceability of timber origin, and establish the legal framework for its certification and digital accounting, among others. Ultimately, the restoration of forests damaged by Russian aggression is a key pillar of Ukraine's National Recovery Plan. While the process will span decades, Ukraine's commitment to ecological restoration represents not only the renewal of its natural heritage but also a model of resilience and sustainability for the global community.

References

Alvarez, M. (2003). Forests in the time of violence: Conservation implications of the Colombian war. *Journal of Sustainable Forestry*, 16: 47–68. DOI: https://doi.org/10.1300/J091v16n03_03.

Athanasiou, M. (2023). Reviving abandoned trees and boosting biodiversity in Varisha and Selemani. Action for Nature Protection in the Buffer Zone. Available online at: https://www.tcecyprus.org/btce-action-areas/nature-protection/action-for-nature-protection-in-the-buffer-zone-reviving-abandoned-trees-and-boosting-biodiversity-in-varisha-and-selemani [accessed on 22 October 2025]. (in Ukrainian)

Basel Institute on Governance (2025). Corruption risks in the forestry sector (as of 01.01.2025). Available online at: https://baselgovernance.org/sites/default/files/2025-03/UA%20Forestry%20and%20Corruption%20report.pdf [accessed on 22 October 2025]. (In Ukrainian)

Basic Principles Strategy of the State Environmental Policy of Ukraine until 2030 (2019). Law of Ukraine No. 2697-VIII of 28 February 2019. Available online at: https://zakon.rada.gov.ua/laws/show/2697-19#Text (in Ukrainian)

Biznes Censor (2023). Environmental damage from Russian military aggression amounts to 3 trillion. Available online at: https://biz.censor.net/news/3403800/ekologichna_shkoda_vid_viyiskovoyi_agresiyi_rosiyi_skladaye_3_trylyiony_minpryrody [accessed on 22 October 2025].

Bosnia and Herzegovina Mine Action Strategy (2009–2019) (2009). Geneva: GICHD. Available online at: https://www.gichd.org/fileadmin/uploads/gichd/Media/GICHD-resources/rec-documents/NMAS-BiH-2009-2019.pdf [accessed on 22 October 2025].

Botnarenko, O.M. (2024). Ecological function of the state in the context of mine action. In: Environmental Safety in Wartime: Proceedings of the 5th International Scientific and Practical Conference (pp. 107–110). Lviv: Lviv State University of Life Safety. Available online at: https://indico.ldubgd.edu.ua/event/54/attachments/664/857 [accessed on 22 October 2025]. (in Ukrainian)

Cabinet of Ministers of Ukraine (2022). Resolution No. 1003 of September 7, 2022. Certain Issues of Reforming the Management of the Forestry Sector. Available online at: https://zakon.rada.gov.ua/laws/show/1003-2022-п#Text (in Ukrainian)

Cabinet of Ministers of Ukraine (2025). Resolution No. 625 of May 30, 2025. On the Implementation of an Experimental Project on the Issuance of Certain Permits in the Forestry Sector in Electronic Form. Available online at: https://zakon.rada.gov.ua/laws/show/625-2025-п#Text [accessed on 22 October 2025]. (in Ukrainian)

Clerici, N., Armenteras, D., Kareiva, P., Botero, R., Ramírez-Delgado, J.P., Forero-Medina, G., Ochoa. J., Pedraza, C., Schneider, L, Lora, C., Gómez, C., Linares, M., Hirashiki, C. and Biggs, D. (2020). Deforestation in Colombian protected areas increased during post-conflict periods. *Scientific Reports*, 10: 4971. DOI: https://doi.org/10.1038/s41598-020-61861-y.

Constantino, C.M. and Eftychiou, E. (2017). The Cyprus Buffer Zone as a socio-ecological landscape. Research Gate. DOI: https://doi.org/10.13140/RG.2.2.30218.88006.

Czúcz, B., Arany, I., Potschin-Young, M., Bereczki, K., Kertész, M., Kiss, M., Aszalós, R. and Haines-Young, R. (2018). Where concepts meet the real world: A systematic review of ecosystem service indicators and their classification using CICES. *Ecosystem Services*, 29(A): 145-157. DOI: https://doi.org/10.1016/j.ecoser.2017.11.018.

Ehrlich, P.R. and Ehrlich, A.H. (1981). Extinction: The Causes and Consequences of the Disappearance of Species. Random House, New York, 72-98. Available online at: https://www.scirp.org/reference/referencespapers?referenceid=1959650 [accessed on 22 October 2025].

Farber, S., Costanza, R., Childers, D.L., Erickson, J., Gross, K., Grove, M. and Wilson, M. (2006). Linking Ecology and Economics for Ecosystem Management.

BioScience, 56(2): 121. DOI: https://doi.org/10.1641/0006-3568(2006)056[0121:leaefe]2.0.co;2.

Filipchuk, B.Y. and Tkachuk, R.L. (2024). Application of artificial intelligence for environmental monitoring during hostilities. In: Environmental Safety in Wartime: Proceedings of the 5th International Scientific and Practical Conference (pp. 111–113). Lviv: Lviv State University of Life Safety. Available online at: https://indico.ldubgd.edu.ua/event/54/attachments/664/857 [accessed on 22 October 2025]. (In Ukraiian)

Fisher, B., Turner, R.K. and Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological Economics*, 68(3): 643–653. DOI: https://doi.org/10.1016/j.ecolecon.2008.09.014.

Francisco, M. (2023). Artificial intelligence for environmental security: national, international, human and ecological perspectives. Current Opinion in Environmental Sustainability. Available online at: https://www.sciencedirect.com/science/article/pii/S1877343522001026 [accessed on 22 October 2025].

Gaynor, Kaitlyn M., Fiorella, Kathryn J., Gregory, Gillian H., Kurz, David J., Seto, Katherine L., Withey, Lauren S., Brashares, Justin S. War and wildlife: Linking armed conflict to conservation (2016). *Frontiers in Ecology and the Environment*, 14: 533–542. DOI: https://doi.org/10.1002/fee.1433

Gowdy, J.M., Howarth, R.B., Tisdell, C.A. (2010). *TEEB: The Economics of Ecosystems and Biodiversity*. London: Earthscan. Available online at: https://www.researchgate.net/publication/241766886_The_Economics_of_Ecosystems_and_Biodiversity_Ecological_and_Economic_Foundations [accessed on 22 October 2025]

Hanson, T., Brooks, T. M., Gustavo, A. B. Da Fonseca, Hoffmann, Michael, Lamoreux John F., Machlis, G., Mittermeier, Cristina G. (2009). Warfare in biodiversity hotspots. *Conservation Biology*, 23 (3): 578–587. DOI: https://doi.org/10.1111/j.1523-1739.2009.01166.x

Khomiak, I.V. (2023). Losses of ecosystem services and assessment of war damages. Materials from hearings held by the Verkhovna Rada Committee on Environmental Policy on the topic: 'The impact of military actions on the environment in Ukraine and its restoration to its natural state' (10 November 2022) Kyiv: Committee of the Verkhovna Rada of Ukraine on Environmental Policy and Nature Management: 71-75. Available online at: https://uncg.org.ua/wp-content/uploads/2023/05/Materialy-slukhan-2-1-1.pdf (in Ukrainian)

Kovtun, D. (2023). Damage caused to the forest fund of Ukraine by the armed aggression of the Russian Federation: ecological and legal aspect. *Law review of Kyiv University of Law*, 3: 115-119. DOI: https://doi.org/10.36695/2219-5521.3.2023.23 (In Ukrainian)

Kovtun, D. (2024). The concept of ecosystem services and the legal foundations for monetization of services provided by forest ecosystems under conditions of Russian armed aggression. *Legal Bulletin*, 4: 225–234. DOI https://doi.org/10.32782/yuv.v4.2024.29 (In Ukrainian)

Kremen, C. and Cowling, R. (2005). Managing ecosystem services: what do we need to know about their ecology? *Ecology Letters*, 8(5): 468–479. DOI: https://doi.org/10.1111/j.1461-0248.2005.00751.x

Landsat Image Gallery (n.d.). NASA. Available online at: https://landsat.visibleearth.nasa.gov/view.php?id=151622

Malysheva, N.R. (2018). Principles of environmental law. In: Yu.S. Shemshuchenko and A.P. Hetman (Eds.), *Great Ukrainian Legal Encyclopedia*, 14. Environmental Law (pp. 626–630). Kharkiv: Pravo (In Ukrainian).

Malysheva, N.R. (2025). Evolution of the phenomenon of environmental legislation realisation under modern challenges. *Almanac of Law*, 16: 61–68. DOI https://doi.org/10.33663/2524-017X-2025-16-61-68 (In Ukrainian)

Ministry of Environmental Protection and Natural Resources of Ukraine (2023). Joint solutions for recovery: how demining forest belts will help Ukrainian communities. Available online at: https://mepr.gov.ua/spilni-rishennya-dlya-vidnovlennya-yak-rozminuvannya-lisosmug-dopomozhe-ukrayinskym-gromadam/ [accessed on 11 November 2025]. (In Ukrainian)

Muravska, M.L. (2013). The concept of an artificial water body as an object of legal relations. *Journal of Kyiv University of Law*, 2: 277–281. (In Ukrainian)

NULES of Ukraine (National University of Life and Environmental Sciences of Ukraine) (2023). How the European Copernicus programme contributes to forest monitoring. Available online at: https://nubip.edu.ua/node/162018 [accessed on 22 October 2025]. (In Ukrainian)

Open Dnister (2023). Wildfires, Mines, Corruption and Logging. What Happens to Ukrainian Forests During War. Available online at: https://dnister.in.ua/articles/257671/pozhezhi-mini-korupciya-ta-virubka-scho-vidbuvayetsya-z-ukrainskimi-lisami-pid-chas-vijni [accessed on 22 October 2025].

Ordway, E.M. (2015). Political shifts and changing forests: Effects of armed conflict on forest conservation in Rwanda. *Global Ecology and Conservation,* 3: 448–460. DOI https://doi.org/10.1016/j.gecco.2015.01.013.

Poliakova, L. and Abruscato, S. (2023). Supporting the recovery and sustainable management of Ukrainian forests and Ukraine's forest sector. Final Report. Available online at: https://foresteurope.org/wp-content/uploads/2023/07/UA-Supporting-the-recovery-and-sustainable-management-of-Ukrainian-forests-and-Ukraines-forest-sector.pdf [accessed on 22 October 2025]. (In Ukrainian)

President of Ukraine (2016). On the establishment of the Chornobyl Radiation and Ecological Biosphere Reserve (Decree No. 174/2016). *Official Bulletin of Ukraine*, (35), Art. 1355. Available online at: https://zakon.rada.gov.ua/laws/show/174/2016#Text [accessed on 22 October 2025]. (In Ukrainian)

Regional Eastern Europe Fire Monitoring Center (n.d.). National University of Life and Environmental Sciences of Ukraine. Available online at: https://nubip.edu.ua/en/node/147103 [accessed on 22 October 2025].

Reuveny, R., Mihalache-O'Keef, A.S. and Li, Q. (2010). The effect of warfare on the environment. *Journal of Peace Research*, 47: 749–761. https://doi.org/10.1177/0022343310382069.

Schumacher, E.F. (1973). Small is Beautiful: Economics as if People Mattered. London: Blond and Briggs.

Shpyliova, Y. and Nosulich, T. (2020). Ecosystem services in the system of incentives for sustainable territorial development. Available online at:

http://dspace.nbuv.gov.ua/bitstream/handle/123456789/163023 [accessed on 22 October 2025].

Sokolova, A.K. (2009). Floristic Law of Ukraine: Problems of Formation and Development. Kharkiv: Pravo (In Ukrainian)

Soloviy, I. (2020). Evaluation of forest ecosystem services in Ukraine and proposals on PES mechanisms. Available online at: https://d2ouvy59p0dg6k.cloudfront.net/downloads/evaluation_of_forest_ecosystem_services [accessed on 22 October 2025]. (In Ukrainian)

Spit, K. (2025). 96% of the territory destroyed by fire — Prosecutor's Office. (2025, January 12). Sudovo-Yurydychna Hazeta. Available online at: https://sud.ua/uk/news/ukraine/320509 [accessed on 22 October 2025]. (In Ukrainian)

State Forest Management Strategy until 2035 (2021). Resolution of the Cabinet of Ministers of Ukraine No. 1777-r of December 29, 2021. (2021). Available online at: https://zakon.rada.gov.ua/laws/show/1777-2021-%D1%80#Text [accessed on 22 October 2025]. (In Ukrainian)

Suietnov, Y.P. (2020). "Ecosystemization" of environmental law objects in the context of implementing the ecosystem approach. *Problems of Legality*, 148, 132–151. http://plaw.nlu.edu.ua/article/view/193603 (In Ukrainian)

Suietnov, Y.P. (2022). Legal issues of forest ecosystem protection and restoration in wartime and post-war periods. In Food and Environmental Security in Wartime and Post-War Times, 238–242. Kyiv: FOP Yamchynskyi (In Ukrainian).

Suietnov, Y.P. (2023). Compensation for losses of ecosystem services during the Russian armed aggression. In: A.P. Hetman (Ed.), *Current Issues of Land, Agrarian and Environmental Law*, pp 132–139. Kharkiv: Pravo. (In Ukrainian)

Tkach, V.P., Vysotska, N.Y., Torosov, A.S., Buksha, I.F., Pasternak, V.P., Los, S.A., Kobets, O.V., Tarnopilska, O.M., Tarnopilskyi, P.B., Kalashnikov, A.O., Zhezhkun, I.M., Koval, I.M., Sydorenko, S.H., Sydorenko, S.V., Bondarenko, V.V. and Bondar, O.B. (2023). Economic Valuation of Forest Ecosystem Services of Ukraine. Kharkiv: UkrNDILGA. Available online at: https://uriffm.org.ua/static/main/files/EcoSys.pdf [accessed on 22 October 2025]. (In Ukrainian)

UNDP (2023). Practical recommendations on determining the destruction of buildings and infrastructure facilities with a classification of degrees of their destruction. Available online at: https://www.undp.org/sites/g/files/zskgke326/files/2023-10/practical_recommendations_on_determining_the_destruction_of_buildings.pdf [accessed on 22 October 2025].

UNESCO World Natural Heritage (2017). Bukovinian Primeval Beech Forests. Available online at: https://gorgany-zapovidnyk.in.ua/location/bukovi-pralisy-vsesvitnoi-pryrodnoi-spadshchyny-yunesko/ [accessed on 22 October 2025]. (In Ukrainian)

UNFCCC (n.d.). Reforestation and Sustainable Development Program in the Pómac Forest – Peru. Available online at: https://unfccc.int/climate-action/momentum-for-change/activity-database/momentum-for-change-%5Creforestation-and-sustainable-development-program-in-the-pómac-forest [accessed on 22 October 2025].

Vasilyuk, O., Kolomytsev, H. and Parkhomenko, V. (2022). Forests in the flames of war: Over 1000 square kilometers lost. Ukraine War Environmental Consequences Work Group. Available online at: https://uwecworkgroup.info (In Ukraine).

Vasyliuk, O. and Hubareva, V (2025). Environmental Consequences of the War in Ukraine – October-November 2025. IUCN World Conservation Congress. Available online at: https://uwecworkgroup.info

Vasyliuk, O., Kuzemko, A., Moysiyenko, I. and Varukha, A. Ecosystem Well-Being. A (2023). Methodology for Calculating Ecosystem Services Using Indirect Methods. Chernivtsi: Druk Art. Available online at: https://www.researchgate.net/publication/373874583_Ekosistemnij_dobrobut [accessed on 22 October 2025]. (in Ukrainian).

Vysotska, N.Y. (2022). Impact of armed conflicts on forest ecosystems in the context of climate change. In: Forests under Modern Challenges: Proceedings of the International Scientific Conference of Young Scientists (pp. 36–38). Kharkiv. Available online at: https://uriffm.org.ua/media/uploads/2022/10/21/tezy2022_uriffm_AhV8GID.pdf [accessed on 22 October 2025].

Zhesniak, A.O. and Bosak, P.V. (2024). Impact of war-induced forest fires on soil condition. In Environmental Safety in Wartime: Proceedings of the V International Scientific and Practical Conference (pp. 111–113). Lviv: Lviv State University of Life Safety. Available online at: https://indico.ldubgd.edu.ua/event/54/attachments/664/857 [accessed on 22 October 2025].

Doi: https://doi.org/10.33002/nr2581.6853.080319 Open Access

Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	*Author 1*	*Author 2*
Conceived and designed the research or analysis	Yes	Yes
Collected the data	Yes	Yes
Contributed to data analysis & interpretation	Yes	Yes
Wrote the article/paper	Yes	Yes
Critical revision of the article/paper	Yes	No
Editing of the article/paper	Yes	Yes
Supervision	Yes	No
Funding Acquisition	Yes	No
Overall Contribution Proportion (%)	60	40

Funding
No financial support was received for the research and writing of this article.

Research involving human bodies or organs or tissues (Helsinki Declaration)
The author(s) solemnly declare(s) that this research has not involved any human subject (body or organs) for experimentation. It was not clinical research. The contexts of human population/participation were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of Helsinki Declaration does not apply in cases of this study or written work.

Research involving animals (ARRIVE Checklist)
The author(s) solemnly declare(s) that this research has not involved any animal subject (body or organs) for experimentation. The research was not based on laboratory experiment involving any kind animal. The contexts of animals were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or ethical obligation of ARRIVE does not apply in cases of this study or written work.

Research on Indigenous Peoples and/or Traditional Knowledge
The author(s) solemnly declare(s) that this research has not involved Indigenous Peoples as participants or respondents. The contexts of Indigenous Peoples or Indigenous Knowledge were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work.

Research involving Plants
The author(s) solemnly declare(s) that this research has not involved the plants for experiment and field studies. Some contexts of plants are also indirectly covered through literature review. Thus, during this research the author(s) obeyed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

Research Involving Local Community Participants (Non-Indigenous) or Children
The author(s) solemnly declare(s) that this research has not directly involved any local community participants or respondents belonging to non-Indigenous peoples. Neither this study involved any child in any form directly. The contexts of different humans, people, populations, men/women/children and ethnic people were only indirectly covered through literature review. Therefore, an Ethical Clearance (from a Committee or Authority) or prior informed consent (PIC) of the respondents or Self-Declaration in this regard does not apply in cases of this study or written work.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
The author(s) has/have NOT complied with PRISMA standards to an extent.

Competing Interests/Conflict of Interest
Author(s) has/have no competing financial, professional, or personal interests from other parties or in publishing this manuscript. There is no conflict of interest with the publisher or the editorial team or the reviewers.

Attribution and Representation
All opinions and mistakes are the author(s)' own and cannot be attributed to the institutions they represent. The publisher is also not responsible either for such opinions and mistakes in the text or graphs or images.

Declaration of the Use of AI
During the preparation of this work, the authors used AI to assists the script translation, language editing, grammar correction, reference management, improving readability and proof reading. The author(s) declared that the use of AI has not compromised originality, leading to plagiarism, or violating data privacy and copyright. Author(s) is/are responsible that AI use complies with ethical standards of research and publication. It is also declared that AI-generated content fabricating data, references or findings is strictly avoided and not included. Author(s) adhered the AI's upper usage limit of 15% as fixed by the journal.

Rights and Permissions

Open Access. This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit http://creativecommons.org/licenses/by/4.0/.

***

To see original copy of these declarations signed by Corresponding/First Author (on behalf of other co-authors too), please download associated zip folder [Declarations] from the published Abstract page accessible through and linked with the DOI: https://doi.org/10.33002/nr2581.6853.080319.